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ASPECTS REGARDING GENERAL VIBRATIONAL BEHAVIOR OF DIESEL ENGINES

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Abstract: *The main vibration source of a vehicle is represented by the internal combustion engine. If we refer to vehicle in motion a considerable vibration source is also represented by the interaction between wheel and running path. One of the first objectives of car manufacturers it is to maintain a low level of vibration amplitudes or almost eliminating the vibrations that could be perceived by passengers. The study highlights aspects regarding the analysis of general vibration behavior of Diesel engines with the porpoise of identifying the vibration amplitudes transmitted by the internal combustion engine to passengers, vibration that are generated at the level of the Diesel engine and passed by the engine thru mountings and received by vehicle passengers. The analysis is focused on Diesel engines because in comparison with gasoline engines they develop higher vibration amplitudes.*
Keywords: *vibration, diesel engine, engine mountings, amplitudes.*

1. INTRODUCTION

Engines beginning with the stage of invention represented besides a revolution in the field of human mobility a source of vibration and noise.
Diesel engines represent a more economic alternative form the fuel consumption point of view but also this type of engines induce a higher amplitude vibration character, in comparison with gasoline engines. Even if in the 90' the vehicles from business class where equipped almost unanimously with gasoline engines, the situation changed in the 2000 when due to high progress of vibration absorbing materials and engine mountings, the noise and vibration caused by Diesel engines where reduced causing the large scale production of Diesel engines that equip business class vehicles.
The main source of vibration at Diesel engines is caused by the self ignition of the fuel and air mixture. The rapidity of ignition and the high temperatures that occur during combustion cause high stresses in the crank rod mechanism. These stresses, vibrations and noise are further more transmitted to the engine block [1], [3], [6]. If the engine block was mounted on rigid mountings all of the generated vibrations caused by combustion had been transmitted to passengers of the vehicle, but now days the mountings of the engine on to the car chassis is made using flexible mountings made by special rubber reinforced with elastic metal insertions [7].

2. CONTENT

In order to accomplish the objective of the study there had been developed several test in order to identify the level of vibration amplitudes, tests performed on 1.9 turbo Diesel engine that equip a certain model of vehicle with the date of manufacturing being placed in the year 2000.
The tests were accomplished using the LMS SCADAS vibration platform. In figure 1 it is presented the 32 channel acquisition platform.

Figure 1. Scadas 32 channel acquisition platform

In order to have a high precision of the data obtained during measuring it were used Tri axial accelerometers model PCB 339A31, which are presented in figure 2.

Figure 2. PCB Tri axial accelerometer

In order to accomplish the measurements first it was developed a data acquisition plan which consisted on:

- measurements accomplished during idle stage engine functioning;
- measurements accomplished during engine functioning at 2000 rpm;

The placement of accelerometers was done considering the following position of accelerometer montage:

- one accelerometer mounted on one of the engine mounting noted with the initials SM (engine mounting);
- one accelerometer mounted on the valve train mechanism block, near to one of the engine cylinder axis noted with the initials REF (reference signal);

In figures 3 and 4 it could be observed the placement of the two accelerometers in the engine subjected to analysis on this study.

Figure 3. Accelerometer mounted on the valve train mechanism block

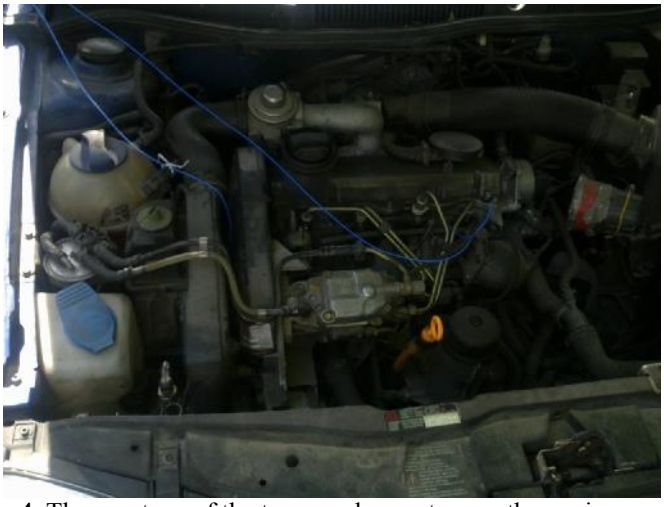

Figure 4. The montage of the two accelerometers on the engine mounting and on the valve train mechanism block

Using the two tri axial accelerometers the study was able to perform tests and gather signals on three directions X, Y and Z. The three directions were considered using practical solutions, the directions considered in this study being used in almost all of the study's which are focused on engine vibration measurements. The considered directions of the signals gathered on the engine are presented in figure 5.

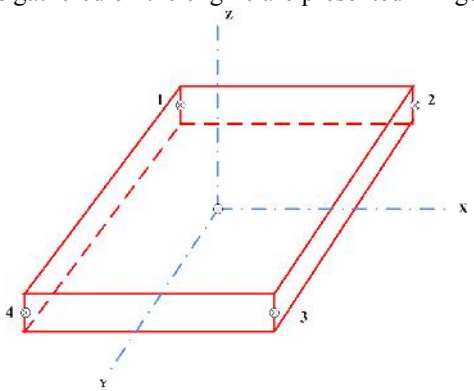

Figure 5. Reference axis consideration

The signal gathered in Z direction at the level of the accelerometer mounted on the engine mounting (SM) is presented in figure 6, in the Waterfall diagram.

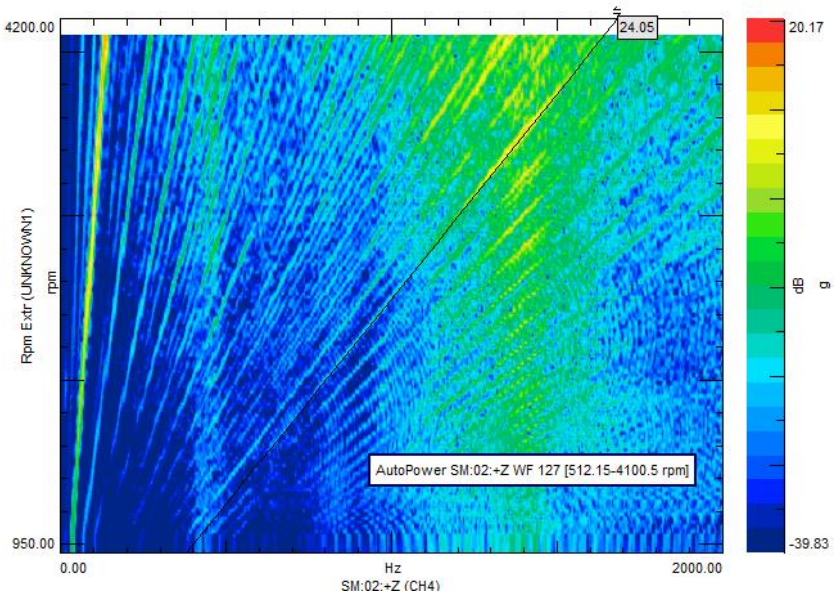

Figure 6. Waterfall diagram signal gathered from the accelerometer mounted on the engine mountings

In figure 6 it could be observed the frequency order that are given by crank revolution. An interesting thing to observe in this diagram are the frequency orders near 1500 Hz, orders that are colored with yellow. These orders indicate the vibration frequency of the engine mounting on which the accelerometer was placed. The other lines marked with yellow color indicate the frequency orders that derive from the fundamental frequency given by the crank revolution speed, these orders are multiples and submultiples of this frequency.
In figure 7 there is highlighted the signal gathered on Z direction during the functioning of the engine at idle regime approximately at 800 rpm.

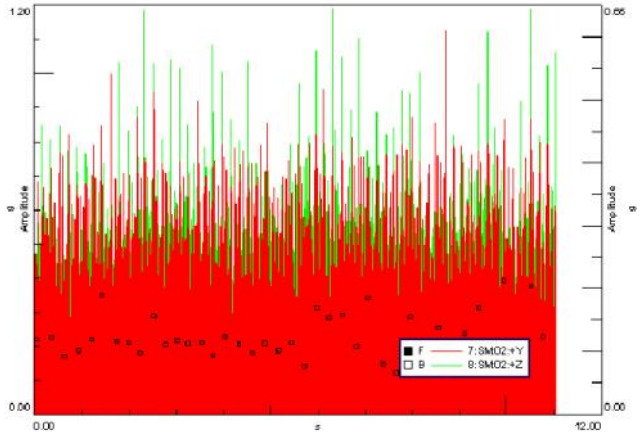

Figure 7. Signal gathered on Z direction at 800 rpm

In figures 8, 9, and 10 there are presented the signals gathered on X, Y and Z direction measured at the level of the engine valve train mechanism block, during engine functioning at stabilized regime 2000 rpm.

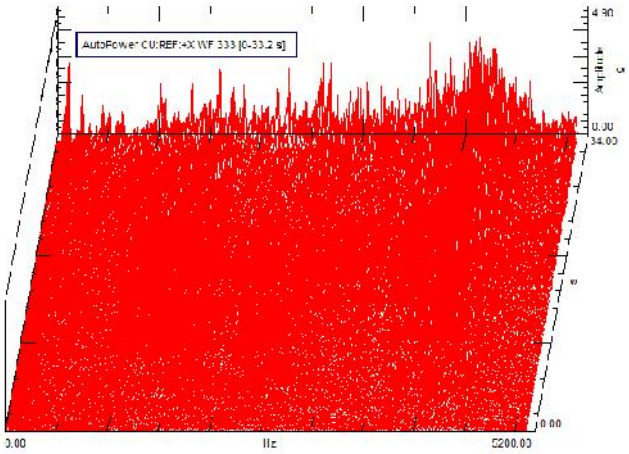

Figure 8. Signal gathered at the level of valve train mechanism on X direction

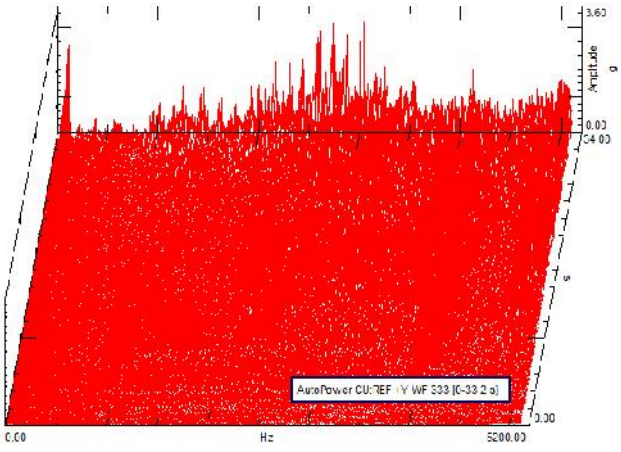

Figure 9. Signal gathered at the level of valve train mechanism on Y direction

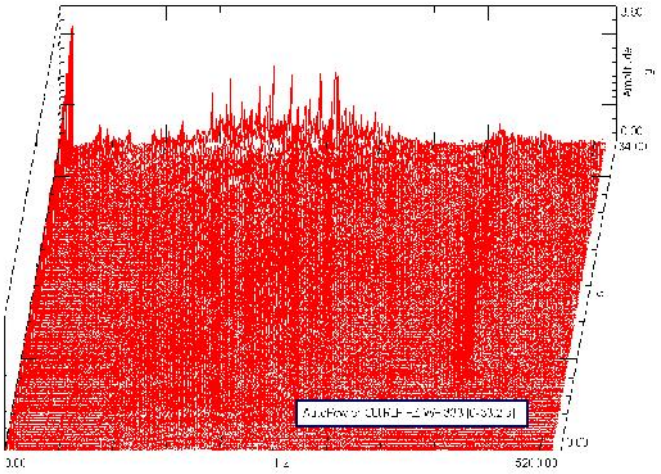

Figure 10. Signal gathered at the level of valve train mechanism on Z direction

3. CONCLUSION

The measurement s accomplished highlight the complexity of engine vibration behavior. During measurements the signals gathered present the fact that vibrations along X axis have the highest amplitudes.
From the point of view of general vibration the signal presented in figure 9 highlights the fact that along this axis the vibrational amplitudes have a more dens spectrum than the other considered directions.
For further analysis it is to be performed several measurements at accelerated regimes where the engine behavior changes.
In order to mitigate the Diesel engine vibration it is imposed the usage of high absorbing materials that compose the engine mountings on to the car chassis [2], [4], [5].
The identified frequency are related to fundamental revolution speed of the crank shaft and engine mountings on to the chassis but there were identified some frequency that there are related to much complex engine behavior.
The study performed highlighted the general level of vibration amplitudes that occur at the level of Diesel engine functioning, observing the engine vibrational behavior from the practical point of view.
The high amplitude level of vibration occurring at the level of the engine could denote in some situations the malfunctioning of the mountings of the engine on to the car chassis.

REFERENCES

[1] Beranek, L., Istvan, L.:Noise and Vibration Control Engineering, Editura John Wiley & Sons, USA, 1997.
[2] Casciati, F., Magonette, G.:Technology of semiactive devices and applications in vibration mitigation, Editura John Wiley & Sons Ltd, U.K, 2011.
[3] Crocker, M.J.: Handbook of Noise and Vibration Control, Editura John Wiley & Sons, USA, 2007.
[4] Crowell, B.: Vibrations and waves, Editura Light and Matter, USA, 2006.
[5] Gafiţanu M.: Diagnosticarea vibroacustică a maşinilor şi utilajelor, Editura Tehnică Bucureşti, 1989.
[6] Giancarlo G.: Vibration dynamics and control, Editura Springer-Verlag, USA, 2009.
[7] Harris M.: Shock and vibration handbook fifth edition, McGraw-Hill, 2002.

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